Claims

1. A vehicle occupancy sensing system comprising:

a first electrode connection and a second electrode connection, where at least one of the electrode connections is a seat back electrode connection;

a circuit parameter sensor connected with the first electrode connection and the second electrode connection; and

a controller coupled to the circuit parameter sensor, the controller operable to obtain a first parameter reading for the first electrode connection and a second parameter reading for the second electrode connection, and operable to determine an occupancy characteristic based on at least one of: (a) a ratio of the first and second parameter readings, (b) a product of the first and second parameter readings, and (c) a derivative form of at least one of the ratio and the product.

2. The vehicle occupancy sensing system of claim 1, where the first electrode connection is a head electrode connection.

3. The vehicle occupancy sensing system of claim 2, further comprising a head electrode coupled to the head electrode connection.

4. The vehicle occupancy sensing system of claim 3, where the head electrode is disposed at a pre-selected head height for a child in a child safety seat

5. The vehicle occupancy sensing system of claim 1, where the second electrode connection is a foot electrode connection.

6. The vehicle occupancy sensing system of claim 5, further comprising a foot electrode coupled to the foot electrode connection.

7. The vehicle occupancy sensing system of claim 6, where the foot electrode is disposed at a pre-selected foot height for a child in a child safety seat.

8. The vehicle occupancy sensing system of claim 1, further comprising a non-switchable return ground connection.

9. The vehicle occupancy sensing system of claim 8, further comprising a return ground electrode coupled to the return ground connection, the ground electrode forming a capacitive sensing circuit in conjunction with at least one electrode coupled to at least one of the first and second electrode connections.

10. The vehicle occupancy sensing system of claim 1, further comprising a first electrode coupled to the first electrode connection and a second electrode coupled to the second electrode connection, and wherein the first electrode and the second electrode are separated by at least a pre-selected vehicle cabin feature distance.

11. The vehicle occupancy sensing system of claim 10, where the vehicle cabin feature distance is a selected belt-buckle dimension.

12. The vehicle occupancy sensing system of claim 1, where the controller is operable to negatively determine occupant presence by applying an occupancy test comprising:

$HL < T1$ and $FL < T2$,

where HL is the first load reading, FL is the second load reading, and T1 and T2 are pre-determined thresholds.

13. The vehicle occupancy sensing system of claim 1, where the controller is operable to determine occupant presence as an occupied rear facing child safety seat by applying an occupancy test comprising:

$FL - HL < T3$ and $(FL/HL) < T4$,

where HL is the first load reading, FL is the second load reading, and T3 and T4 are pre-determined thresholds.

14. The vehicle occupancy sensing system of claim 1, where the controller is operable to determine occupant presence as an occupied front facing child safety seat by applying an occupancy test comprising:

$FL - HL > T5$ and $(HL/FL) > T6$,

where HL is the first load reading, FL is the second load reading, and T5 and T6 are pre-determined thresholds.

15. The vehicle occupancy sensing system of claim 1, where the controller is further operable to obtain an occupant age estimation based on the first and second parameter readings.

16. The vehicle occupancy sensing system of claim 15, where the controller is operable to obtain the occupant age estimation by comparing at least one of the first and second parameter readings to an age threshold after determining the presence of a child safety seat.

17. The vehicle occupancy sensing system of claim 1, where the controller is further operable to disable air bag activation based on the determination of occupant presence.

18. The vehicle occupancy sensing system of claim 1, where at least one of the first and second parameter readings is a load current reading.

19. The vehicle occupancy sensing system of claim 1, where the product comprises at least one of a load impact sum and a load impact difference.

20. The vehicle occupancy sensing system of claim 19, where the first parameter reading is a first load reading, where the second parameter reading is a second load reading, and where the load impact sum comprises a sum of load impact based on the first load reading, the second load reading, a first electrode connection unloaded reading, and a second electrode connection unloaded reading.

21. The vehicle occupancy sensing system of claim 19, where the first parameter reading is a first load reading, where the second parameter reading is a second load reading, and where the load impact difference comprises a difference of load impact based on the first load reading, the second load reading, a first electrode connection unloaded reading, and a second electrode connection unloaded reading.

22. The vehicle occupancy sensing system of claim 1, where the controller is further operable to determine occupant presence based on an upper threshold and a lower threshold.

23. The vehicle occupancy sensing system of claim 1, where the controller is further operable to determine occupant presence based on at least one of a ratio threshold and a product threshold.

24. The vehicle occupancy sensing system of claim 23, where at least one of the ratio threshold and the product threshold is a front facing child seat threshold.

25. The vehicle occupancy sensing system of claim 23, where at least one of the ratio threshold and the product threshold is a rear facing child seat threshold.

26. A method for sensing vehicle occupancy comprising the acts of:

sensing a first parameter associated with a first electrode connection;

sensing a second parameter associated with a second electrode connection, where at least one of the first and second electrode connections is a seat back electrode connection; and

comparing at least one of: (a) a product based on the first and second parameter readings, (b) a ratio based on the first and second parameter readings, and (c) a derivative form of at least one of the ratio and the product.

27. The method of claim 26, where the act of comparing comprises comparing against at least one of an upper threshold, a lower threshold, and a ratio threshold that is an occupied child safety seat threshold.

28. The method of claim 27, where the upper threshold comprises a rear facing child seat threshold and where the lower threshold comprises a forward facing child seat threshold.

29. The method of claim 26, where sensing a first parameter comprises the act of sensing a first load through an upper body electrode coupled to the first electrode connection.

30. The method of claim 29, where the upper body electrode is disposed at a pre-selected upper body height for an occupied child restraint device.

31. The method of claim 26, where sensing a second parameter comprises the act of sensing a second load through a lower body electrode coupled to the second electrode connection.

32. The method of claim 31, where the lower body electrode is disposed at a pre-selected lower body height for an occupied child restraint device.

33. The method of claim 26, where comparing comprises the act of comparing the product based on the first and second parameter readings against at least one of a first upper threshold and a first lower threshold and against at least one of a second upper threshold and a second lower threshold.

34. The method of claim 33, where the first and second upper threshold are age distinguishing thresholds.

35. The method of claim 33, where the first and second lower thresholds are age distinguishing thresholds.

36. The method of claim 26, further comprising the act of setting a presence indicator when at least one of the product and the ratio crosses at least one threshold.

37. The method of claim 26, further comprising the act of disabling an airbag based on the comparing.

38. The method of claim 26, further comprising the act of applying an occupancy test comprising:

$HL < T1$ and $FL < T2$,

where HL is the first load reading, FL is the second load reading, and T1 and T2 are pre-determined thresholds.

39. The method of claim 26, where comparing comprises the act of applying a rear facing child safety seat occupancy test comprising:

$FL - HL < T3$ and $(FL/HL) < T4$,

where HL is the first load reading, FL is the second load reading, and T3 and T3 are pre-determined thresholds.

40. The method of claim 26, where comparing comprises the act of applying a front facing child safety seat occupancy test comprising:

FL - HL > T5 and (HL/FL) > T6,

where HL is the first load reading, FL is the second load reading, and T5 and T6 are pre-determined thresholds.

41. The method of claim 26, where at least one of the first electrode connection and the second electrode connection is a head electrode connection.

42. The method of claim 26, where at least one of the first electrode connection and the second electrode connection is a foot electrode connection.

43. A machine readable medium encoded with instructions that cause a vehicle electronics system to perform a method comprising the acts of:

sensing a first parameter associated with a first electrode connection;

sensing a second parameter associated with a second electrode connection, where at least one of the first and second electrode connections is a seat back electrode connection; and

applying an occupancy sensing test comprising at least one of:

comparing a ratio based on the first and second load readings,

comparing a product of the first and second parameter readings, and

comparing a derivative form of at least one of the ratio and the product.

44. The machine readable medium of claim 43, where the act of comparing comprises the act of comparing against at least one of a first and second pre-selected threshold that is an occupied child safety seat threshold.

45. The machine readable medium of claim 44, where at least one of the first and second pre-selected thresholds is a forward facing child safety seat threshold.

46. The machine readable medium of claim 44, where at least one of the first and second pre-selected thresholds is a rear facing child safety seat threshold.

47. The machine readable medium of claim 43, where sensing a first load comprises sensing a first load through an upper body electrode coupled to the first electrode connection.

48. The machine readable medium of claim 47, where the upper body electrode is disposed at an upper body height for an occupied child restraint device.

49. The machine readable medium of claim 43, where sensing a second load comprises the act of sensing a second load through a lower body electrode coupled to the second electrode connection.

50. The machine readable medium of claim 49, where the lower body electrode is disposed at a lower body height for an occupied child restraint device.

51. A vehicle occupancy sensing system comprising:

a first electrode in a seat back;

a second electrode in the seat back;

a third electrode in a seat base, the third electrode non-switchably connected to a relative ground;

a circuit parameter sensor connected with the first and second electrodes; and

a controller coupled to the load sensor, the controller operable to obtain a first parameter reading for the first electrode and a second parameter reading for the second electrode, and operable to output a signal as a function of the first and second load readings.

52. The vehicle occupancy sensing system of claim 51, where the function comprises a ratio of the first and second parameter readings.

53. The vehicle occupancy sensing system of claim 51, where the function comprises a product of the first and second parameter readings.

54. The vehicle occupancy sensing system of claim 51, where at least one of the first and second parameter readings is a load current reading.

55. The vehicle occupancy sensing system of claim 51, where at least one of the electrodes is a head electrode disposed at an upper body height for an occupied child restraint device.

56. The vehicle occupancy sensing system of claim 51, where at least one of the electrodes is a foot electrode disposed at a lower body height for an occupied child restraint device.